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DEVICE FOR MALTING GRAIN

The invention relates to a device for malting grain, comprising a tower with several tiers, which are separated from each other by tier floors, wherein each tier comprises an air-permeable carrying floor to support the grain to be germinated, along with air conditioning agents for conditioning the air and displacement means, it is provided with a supply canal and discharge canal for displacing conditioned air via the supply canal, which extends starting from the air conditioning means to the bottom side of a carrying floor, through the carrying floor and a grain layer lying thereupon to the upper side of the grain layer, and via the discharge canal and away from the upper side of the grain layer, wherein the supply canal and/or discharge canal extends through a central opening into at least one tier floor.

A generic device has been operational since 1972 at the facility of the Bavaria N.V. company in Lieshout, Netherlands. This device has a tower with annular carrying floors rotatable around an axis, which are located between two overlying tier floors. The carrying floors are supported on both the inner diameter and outer diameter. The inner diameter of the annular carrying floor measures 6 meters, while the outer diameter of the carrying floor (and tier floors) measures 20 meters. Conditioned air is supplied by way of a lockable opening in the side wall of the tower, wherein conditioned air can also exit the tower again via an opening in the side wall of the tower after a grain layer has passed on a carrying floor. Even though the tower according to prior art is technologically excellent, there is a demand for further increasing the capacity of such devices. At first glance, one logical solution would be to increase the outer diameter of the

tier floor, so that a larger quantity of grain can be treated per carrying floor. From a practical standpoint, however, structural limitations make it impossible to implement this solution, wherein it increasing the outer diameter of the carrying floor obviously causes the weight of the grain layer to increase by a power of two, with the overstress length rising as well. This task combined with the fact that it is often undesired to design the carrying floors as rotatable around their perpendicular cardoid line is why a device can technically not be constructed in this way, at least not in an economically feasible way. In addition, it is generally also required from at least a structural standpoint to make the bearing structure for the carrying floors as light as possible.

The object of the invention is to create a grain malting device that can in principle be used to economically realize a significant increase in capacity and/or utilize a lighter bearing structure for the carrying floors given the same capacity. To this end, the device according to the invention is characterized in that the supply canal and/or discharge canal extend through a central opening in at least one tier floor. The invention is based on the view that the capacity of a device can be increased by enlarging the inner diameter and outer diameter of a carrying floor to the same extent in an absolute sense, so that the length of radial overstress remains constant, while a larger number of radial supports can simultaneously be used to carry the higher weight of the grain layer, which lies on the carrying floor. In addition or as an alternative, it is possible, at a more or less constant capacity requirement, to increase the outer diameter to less of an extent as the inner diameter in absolute terms, thereby reducing the length of the radial

overstress, so that a lighter bearing structure can in principle be used for the carrying floors.

In addition, the length of a potentially radially oriented winch used to load or unload the carrying floor can be shortened, while the number of mixing elements normally arranged in a radial series can also be lower. Further, grain located near the inner diameter on the carrying floor can be machined more easily depending on the size of the inner diameter.

To give such a structure an economic design, at least the space within the inner diameter of a tier floor with comparable dimensions to those of the carrying floor are used according to the invention for passing through a (portion of the) supply canal and/or (a portion of the) discharge canal. Another advantage here is that no arrangements need in principle be present on the outside of the tower for supplying conditioned air to the lower side of a loaded carrying floor and/or for discharging "used" air starting from the upper side of the grain layer, even though such devices on the outside of the tower can be present within the framework of the invention, provided that the supply canal and/or discharge canal extends (partially) through the central opening.

Another improvement relative to central space utilization inside the inner diameter is achieved by having the supply canal and discharge canal extend through a central opening in at least one tier floor.

The discharge canal preferably empties out at the air conditioning means. Hence, the discharge canal serves as a return line, and at least a portion of the (conditioned) air can be circulated, which has a positive effect on energy consumption. How much

conditioned air circulates can be adjusted with regulators, which set the ratio between conditioned air supplied to the air conditioning means and conditioned air discharged to the outside environment.

As an alternative to or in combination with the aforementioned preferred embodiment, the device according to the invention is preferably further characterized in that the discharge canal empties into the outside environment of the tower. If this preferred embodiment is combined with the above preferred embodiment, a branched discharge canal is preferably present, wherein a first branched portion of the discharge canal empties into the outside environment of the tower, and a second branched portion of the discharge canal empties at the air conditioning means. The space over the grain layer can here also serve as a branch, in that this space has both an opening for a return line, e.g., on the radial inside of the space, as well as a (size-adjustable) opening to the outside environment of the tower, e.g., on the radial outside of the space. A suitable valve system makes it possible to generate a desired distribution of the quantity of air routed (back) starting from the upper side of the grain layer to the air conditioning means, and which is discharged to the outside environment of the tower.

Primarily in conjunction with the circulation favorable for energy-related reasons, it is preferred that the supply canal and discharge canal, which belong to the same carrying floor, extend adjacently through a central opening in a tier floor. This makes it possible to set up a circulation loop relatively easily.

It is further preferred that the at least one central opening through which the supply canal and/or discharge canal extends is circular. Such a cross section is

advantageous primarily when the carrying floor is rotatable in design according to another embodiment.

Given a circular central opening, it is preferred that the supply canal and/or discharge canal have an at least primarily segmented cross section at the location of the at least one central opening, which at the very least also connotes a blunt, segmented shape.

The advantages of the invention come to the fore primarily when the diameter of the at least one circular, central opening has a size of at least 10 meters, and further preferably of at least 12 meters. This is because, at such a diameter, the surface carries a sufficient flow to provide a number of tiers with sufficiently conditioned air.

The capacity can be increased relative to the device according to prior art by having each carrying floor be primarily annular, wherein the size of the inner diameter is at least 10 meters, preferably 12 meters.

The carrying floor here preferably has a radial overstress between the inner diameter and outer diameter of at least 7 meters, yielding an increased bearing capacity per overstress length unit relative to prior art.

The advantages to the invention are evident above all when the carrying floor can revolve around a rotational axis that extends through the cardoid line of the annular shape. If the carrying floor can rotate, the loading floor can be easily loaded or unloaded by means of a winch extending in a radial direction.

A compact design with limited space requirements can be obtained by arranging the air conditioning means under

the level of the tier floor beneath the first carrying floor for the grain to be germinated, or by locating the air conditioning means over the level of the tier floor above the uppermost carrying floor of the tower. As an alternative or in addition, it is also possible for such devices to be present in the supply canal, provided they extend through the central opening. Primarily an adiabatic coolant is possible here, wherein water evaporation takes place.

As an alternative or in combination, it is preferred that the air conditioning means be located within the outer periphery of the tier floors to keep the device structure compact.

From a logistical standpoint, it is further preferred that another carrying floor to support germinated grain to be dried be provided under the level of the tier floor beneath the lowermost carrying floor for the grain to be germinated. This makes it possible to use gravity to easily displace germinated grain to other carrying floors, where the drying process can take place.

In terms of structural design and technological aspects, it is here preferred that the other carrying floor for the germinated grain to be dried have similar dimensions as the carrying floors for the grain to be germinated.

The invention will be outlined in greater detail below based on the description of a preferred embodiment of the device, wherein reference is made to the figures.

Fig. 1 shows a perspective view of a malting device according to the invention with two towers,

of which only one is partially visible, and the other is partially open;

Fig. 2 shows an open and partially transparent perspective view of a tower according to Fig. 1.

Fig. 1 shows a malt factory 1 with a dual design in which two towers 2, 3 are present. Fig. 2 shows the tower 2 in detail. Tower 2 consists of three tiers 4, 5, 6, which are defined by tier floors 7, 8, 9, 10, wherein the tier floor 10 also constitutes the roof of the tower 2. Even though not applicable to this embodiment, it is conceivable to provide a soaking space on the roof where the grain is soaked prior to malting.

Situated between the corresponding tier floors 7, 8, 9, 10 are carrying floors 11, 12, 13. Both the tier floors 7, 8, 9, 10 and carrying floors 11, 12, 13 are annular, so that a cylindrical space 14 is present within the corresponding inner diameter of the tier floors and carrying floors. This cylindrical space 14 is divided into seven matching, perpendicular canals 15, 16, 17, 18, 19, 20, 21, which all are identical in shape in horizontal cross section, namely shaped like a truncated segment. Situated between the canals 14 to 21 is a central passage 22. The canals 15 to 21 extend over the entire height of the tiers 4 to 6, and are separated from each other by radial intermediate walls, which also extend to under the level 4, where air conditioning means yet to be described in greater detail are located.

The carrying floors 11, 12, 13 can be rotated around the cardoid line of the tower 2 by means of driving means (not shown in any greater detail), to which end the carrying floors 11, 12, 13 are provided with guided

support by rollers on both their inner diameter and outer diameter. Visible on Fig. 1 are rollers 23 on the outer diameter of the carrying floor 13. The carrying floors 11, 12, 13 are perforated in such a way that they are permeable to air on the one hand, in particular to conditioned air, but also are able to carry a layer of grain 24 to be germinated on the other.

Grain is supplied to the corresponding carrying floors 11, 12, 13 via the supply line 25 over the roof 10 of the tower 2. Even though the supply lines 25 for towers 2 and 3 together form an angle on Fig. 1, it is also conceivable, or even more advantageous, to run the two supply lines as mutual extensions, comprising a shared conveyor belt that can be driven in two opposite directions, and on which grain to be malted can be poured. The supply line 25 bends downwardly precisely over the canal 19, branching into three lines 27, 28, 29 over the distribution element 26. The branching lines 27, 28, 29 bend outwardly in a radial direction at their lowermost ends, emptying out on the corresponding carrying floors 11, 12, 13. The distribution element 26 incorporates a distribution unit that makes it possible to selectively pass grains over the corresponding branching lines 27, 28, 29, thereby loading the carrying floors with grain. Located over these carrying floors 11, 12, 13 is a stripper extending in a radial direction. Visible on Fig. 1 are the strippers 30, 31 over the carrying floors 12, 13.

A suitable drive for rotating both the carrying floor 11, 12, 13 and the accompanying strippers 30, 31 makes it possible to provide the corresponding carrying floor 11, 12, 13 with a grain layer having a uniform thickness. Taking into account that the inner diameter of the carrying floors 11, 12, 13 measures 12 meters,

and the outer diameter measures 32 meters, while a typical height of the grain layer on a carrying floor measures 1.2-1.4 meters, the weight of the grain layer carried by a carrying floor 11, 12, 13 measures approx. 440,000 kg (initial product). The bottom sides of the carrying floors 11, 12, 13 are therefore constructed with radial support beams so that this enormous weight can be carried.

In order to slowly germinate the grain on the carrying floor 11, 12, 13 that is moistened before transported to the carrying floor 11, 12, 13, it is necessary to treat the grain with conditioned air, during which enzymes break open the cell walls in the grain seeds, so that the starch in the grain seeds becomes accessible. This germination process is terminated within the tower 2 in a timely fashion to prevent the grain seeds from actually growing into a plant. To terminate this germination process, the grain seeds are dried in another system. This drying process is also referred to as kilning.

As evident from Fig. 1, the end of each stripper 30, 31 on the outside of the tower 2 (and 3) has a discharge opening that adjoins a perpendicular down pipe 32, whose open bottom side empties over a transport belt with which the germinated grain can be routed to a dryer below in the tower 2. It takes about 6 days to germinate the grain, while the drying process only takes about 1 day.

In order to process the grain on the carrying floors 11, 12, 13, the tower 2 has separate devices for each carrying floor 11, 12, 13, both for displacing air along the corresponding grain layers, and for conditioning this air. Typical conditions for conditioning this air are 12-18 °C and an atmospheric

humidity of 40-100 %. In addition, a CO₂ percentage of about 2 % can be used, depending on how far the germinating process has progressed.

The function of the device for grains on the lowermost carrying floor 11 will be explained below. Situated under the tier floor 7 is a fan with an aspiration opening 33 and an exiting blast outlet 34. This blast outlet 34 empties under the lowermost end of the canal 16. A horizontal separating wall not shown in greater detail is situated in the canal 16 at the level of the carrying floor 11. Situated between the tier floor 7 and carrying floor 11 inside the canal is an outflow opening 35 on the outside of the cylindrical space 14. Conditioned air routed to the fan 32 passes through this outflow opening 35 and into the annular space 36 between the tier floor 7 and carrying floor 11. Because overpressure prevails in this space 36, while a low overpressure is present in the annular space 37 between the carrying floor 11 and tier floor 8, the conditioned air streams through the permeable carrying floor 11 and the grain layer carried by the carrying floor 11. Air inside the annular space 37 exits this space 37 again via the flow-through opening 38 on the outside of the cylindrical space 14, which borders the canal 15 and is located between the level of the carrying floor 11 and tier floor 8. Situated both above and below the opening 18 inside the canal 15 is a valve, which makes it possible to regulate what percentage of air flows through the opening 38 and is upwardly diverted into the canal 15, so as to leave the tower 2 or become downwardly diverted according to arrow 32. This portion of air is intended for recirculation, and is aspirated by the fan 32.

The bottom end of the canal 15 empties in an underpressure chamber 40 with an outflow opening to the

suction chamber 42 with the aspiration opening 33 located therein. The suction chamber 42 can also be reached by ambient air according to arrow 43, to which end a suitable opening (not shown in any greater detail) is of course provided in the outer wall of the tower 2. The ratio between recirculated air (arrow 39) and outside air (arrow 43) aspirated by the fan can be determined by setting the revolving door valve 44, which can be turned around a rotational axis 45. This revolving door valve 44 also makes it possible to completely seal the underpressure chamber 40, wherein the fan 32 aspirates outside air only (arrow 43), and to avoid outside air (arrow 43) from being aspirated, and prevent the fan 32 from aspirating only air that has already traversed the grain layer on the carrying floor 11 at least once (arrow 39). Fig. 2 does not show the air conditioning means, such as cooling blocks, used to bring the air to the correct temperature, and atomizers for bringing the air to the correct humidity, but could be located in the suction chamber 42 or blast outlet 34, for example.

The grain layer is treated on the carrying floor 12 in a completely comparable manner. A fan 46 blows air from the bottom side into the canal 20, wherein the air passes the outflow opening 46 to arrive at the annular space 47 between the tier floor 8 and carrying floor 12. The air then traverses the carrying color 12 and the grain layer lying thereupon, after which the air exits the annular space 48 between the carrying floor 12 and tier floor 9 again through the outflow opening 49. Depending on the states of the various suitable valve, the air is then upwardly diverted to exit the tower 2 via the upper end of the canal 21, or downwardly diverted (according to arrow 50) owing to the aspirating effect of the fan 46.

Comparable arrangements are also provided for the grain layer 24 on the carrying floor 13, wherein conditioned air is passed via the bottom side of the canal 18 to the grain layer 24, and air that has passed the grain layer 24 is either expelled outside the tower 2 via the canal 17, or relayed back to the fan belonging to the floor 13.

The described malt factory offers the advantage of expanded and economic performance due to the relatively large inner diameter of the carrying floors 11, 12, 13, in that the cylindrical space 14 is used to accommodate necessary lines for supplying and removing conditioned air to and from a grain layer. The cylindrical space 14 is also used for supplying grain to the corresponding carrying floors 11, 12, 13. In addition, the seventh canal 17 is used to remove and supply water, energy (electricity) and air or compressed air.